5 BASIC BMP OPTIONS

Several of the Basic BMPs recommended in this chapter are common landscaping practices for home lawns and garden and all are intended for easy and aesthetic implementation. Additional internet references are provided for more information:

http://www.santabarbaraca.gov/Resident/Water/Water_Conservation/WCLandscaping.htm

http://www.santabarbaraca.gov/Resident/Water/Water_Conservation/WCEducation.htm

http://www.santabarbaraca.gov/Resident/Water/Water_Conservation/WCBrochuresandmore.htm

http://www.santabarbaraca.gov/Resident/Community/Creeks/Pesticides.htm

http://www.santabarbaraca.gov/Resident/Community/Creeks/Low_Impact_Development.htm

5.1 How to Choose Basic BMPs

After the site has been assessed and possible locations for BMPs identified, it is time to identify which BMPs may be appropriate for the site. Tier 3 projects are required to have a detailed soil and site analysis completed, as discussed in Chapter 3. However, Tier 1 and Tier 2 projects may opt to perform simple infiltration and soil tests to determine if the site is amenable to infiltrative BMPs, which types of vegetation will live in such conditions, and if soil amendments would aid in improving water quality and the infiltration capabilities of the site; all of these items are addressed in this chapter. The basic BMP options in this chapter are easier to implement than those in Chapter 6 and are more appropriate for implementation by individual homeowners (Tier 1 and Tier 2 projects). The basic BMP options are also intended for implementation by Tier 3 projects, where applicable.

While all of the BMPs in this section will contribute to reducing storm water runoff volume, rate, and/or pollutants from the site, they are not adequate to meet the storm water runoff requirements as outlined in Chapter 6. However, since all of the basic BMPs mitigate the effects of storm water runoff and lessen the burden of required treatment and hydrologic control, these BMPs implicitly reduce the storm water runoff requirements in Chapter 6 and should be considered a critical component of implementing LID principles at any site. There are a variety of basic BMPs available providing options for designers to achieve site-specific customization based on site constraints, local topography, design standards, and climate. Basic BMPs:

- Contribute to a location's aesthetic appeal,
- Aid in water conservation,
- Protect local creeks and oceans from pollution carried by storm water runoff,
- Reduce a site's water usage and costs, and
- Create wildlife habitat.

Table 5-1 compares the different BMPs in this chapter based on their ease of implementation, relative cost, and soil infiltration requirements.

Table 5-1: Matrix Table for Comparison of Basic BMP Options

Important Note to Users: Site suitability can vary widely for individual BMPs. This table should be used to provide general BMP comparisons only.

Manual Section	Basic BMP Option	Ease of Implementation[1]	Relative Cost[2]	Infiltration Capacity Requirement[3]	Suitable for site with slope >15%
5.3	**Disconnected Downspouts**	2	$	Y	Y/N
5.4	**Flow Spreading**	2	$-$$$$	Y	N
5.5	**Rain Gardens**	4	$-$$$$	Y	N
5.6	**Rain Barrels**	2	$-$$$	Y/N	Y
5.7	**Contained Planters**	1	$-$$$$	N	Y
5.8	**Depression Storage**	4	$-$$$	Y	N
5.9	**Permeable Pavement**	2	$$-$$$$	Y	N
5.10	**Soil Amendments**	3	$-$$$$	Y/N	Y
5.11	**Landscaping Considerations**	1	$-$$$$	Y/N	Y

[1]

Easy	Easy to Medium	Medium	Medium to Difficult
1	2	3	4

[2]

$0-$50	$50-$100	$100-$500	more than $500
$	$$	$$$	$$$$

[3] Y - infiltration capacity required for BMP implementation;
N - Infiltration capacity is not a concern for implementation;
Y/N depends on how it is implemented

5.2 Site Assessment *(recommended for Tiers 1 and 2; this assessment is NOT intended for Tier 3 projects)*

5.2.1 Soil Assessment

An important step in assessing your site for determining which BMPs are applicable or will perform as desired is to assess your soils. A soil assessment helps determine if the soils at the site exhibit enough infiltration for infiltrative BMPs to function successfully and helps characterize the types of soil present. This assessment allows you to determine if an infiltrative BMP will work at your site and may also aid in determining which types of vegetation will thrive at your site.

Simple Infiltration Test

To determine if there is adequate infiltration at your site for implementing an infiltration BMP, it is necessary to conduct a simple infiltration test as described in the following steps.

1. Dig a hole about 6 inches deep
    a. Make sure that the hole does not show any evidence of macropores (i.e., tunnels dug by burrowing animals, rotted tree trunks, etc.). If macropores are present, an alternative location should be chosen for the simple infiltration test because you will be measuring the capacity of the macropore rather than the infiltration of the soil.
2. Fill the hole with water
    a. If the water does not soak in within 24 hours then it is not feasible to implement an infiltration BMP.

Simple Texture by Feel Test

Determine the type of existing soil by conducting a simple texture by feel test. Knowing the soil type will allow you to determine which options will be most effective, including vegetation and soil amendments. The following steps will help determine the existing soil type.

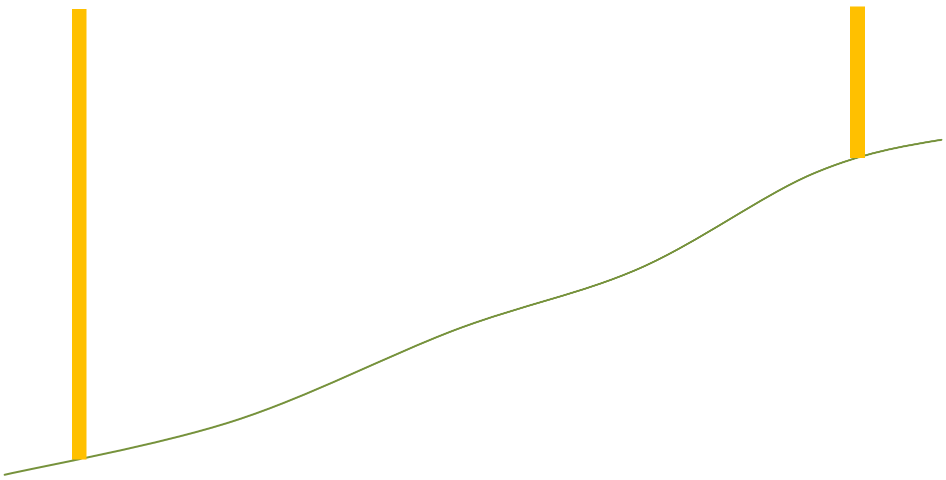
1. Grab a handful of soil
2. Add a bit of water to the soil while kneading it to distribute the moisture
    a. As you are kneading the soil it should eventually feel like putty and form a ball
    b. If it never reaches this point and it feels gritty, your soil is mostly sand and therefore offers good infiltration.
3. Once the soil forms a ball when kneaded, hold it in the palm of one hand and begin rolling it with the fingers of the other hand into a coil about 1/10" thick. Allow the coil to drape over the edge of your finger as it gets longer.
    a. If the coil is less than 1 inch when it breaks your soil is sandy loam
    b. If the coil is longer than an inch, examine the soil more closely.
        i. Does it feel sticky, look shiny, and form a very long coil without breaking?
            1. Then it is more clay than loam
        ii. Does it feel soft, not sticky, and look dull? Does the coil break?
            1. Then it is more loam than clay
        iii. If your soil is more clay **OR** more loam (i.e., more sticky or more soft)
            1. Does it feel gritty/sandy at all?
                a. Sand is present
            2. Does it feel like smooth like flour?
                a. Silt is present
4. Most soil is a combination of clay, silt, and sand. Soils that form long coils and feel sticky or smooth tend to hold more water and therefore if your soil has these characteristics, then infiltration BMPs are not appropriate for your site. Chances are that the water will not completely drain from the hole in the specified amount of time (24 hours). Try it and see. Soils that feel gritty and soft probably are good candidates for infiltration; check to see that they infiltrate as required by performing the simple infiltration test described above.

5.2.2 Site Slope Assessment

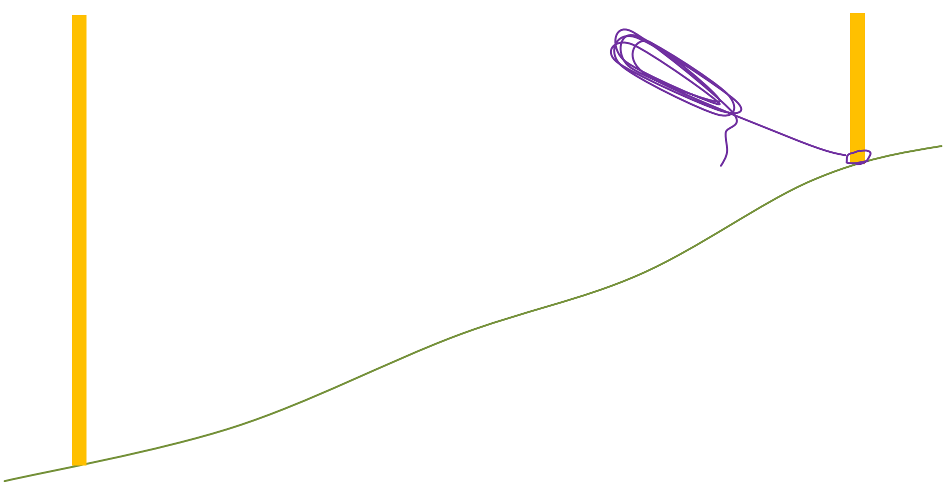
Simple Slope Measurement

To measure the slope for the purposes of determining if the location is amenable to certain BMPs (i.e., those that require the slopes to be less than 15%) follow the instructions below.

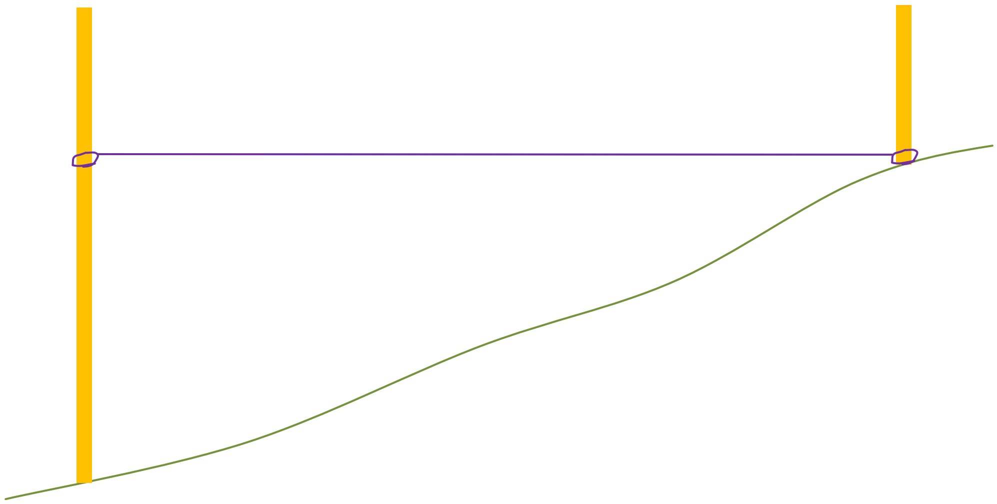
Mark out the area to be measured, place a stick at the top (upslope) point and another at the bottom (downslope) point.



Once the marking sticks are in place, it is time to attach a string (that is long enough to reach between both of the sticks) to the base of the upslope stick.



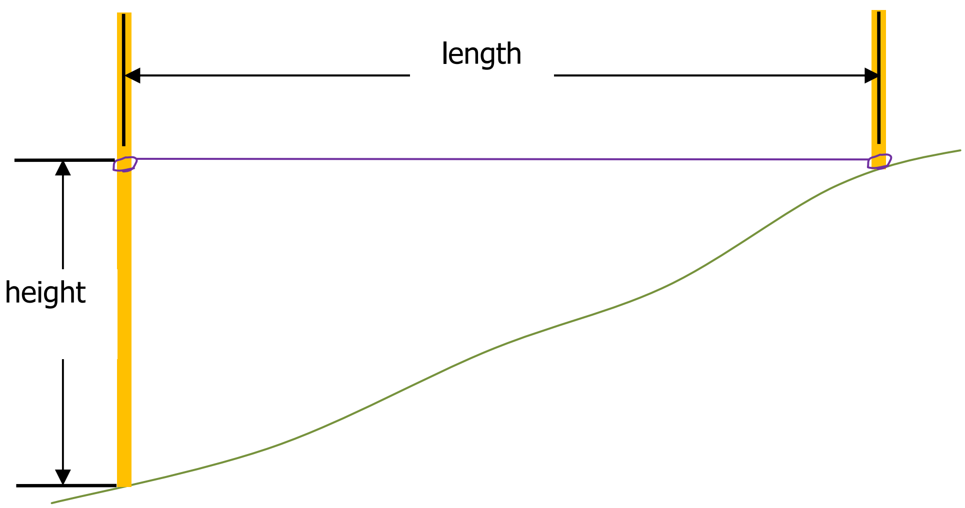
Stretch the string from the downslope side and affix. Before conducting any measurements ensure that the string is level.



Measure:

The length of the string that is stretched between the sticks.

The height of the string on the downslope stick (from ground level to string level).



Calculate the percent slope

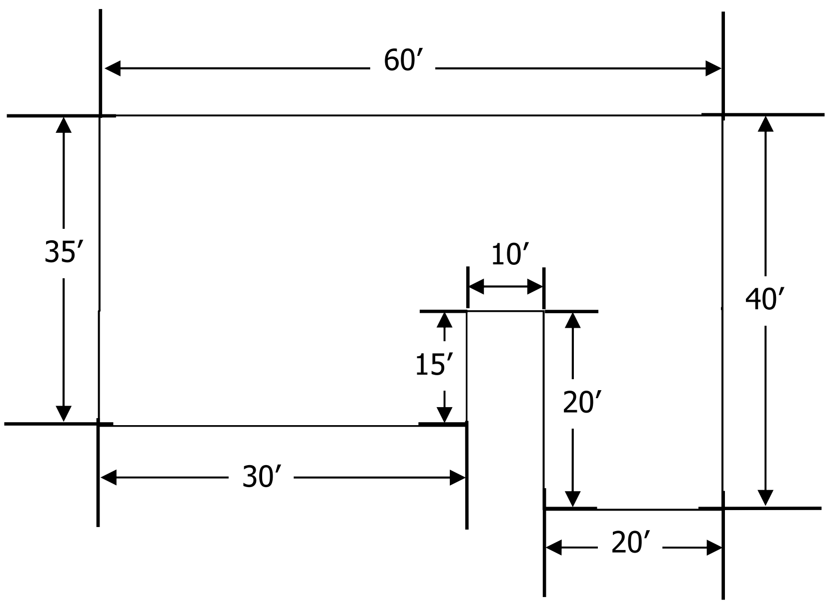
Percent slope = difference in height between the two sticks divided by the distance between sticks. Both measurements need to be in the same measurement units. For example, if the distance between the two sticks is 5 feet and the height is 6 inches, the 6 inches should be divided by 12 (for the number of inches in a foot) to change from inches to feet; therefore, the height equals 0.5 feet. The % slope is equal to 5 feet divided by 0.5 feet multiplied by 100%, which equals a slope of 10%.

$$\% \, slope = \frac{Height}{Length} \times 100\%$$

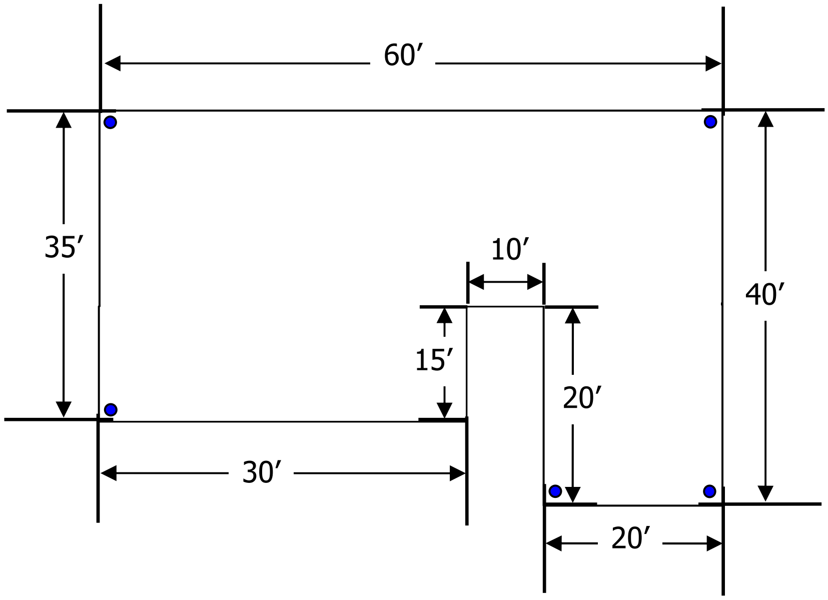
5.2.3 Roof Area Assessment

This section provides guidance for estimating the impervious area of your roof that drains to the different downspouts located around your house.

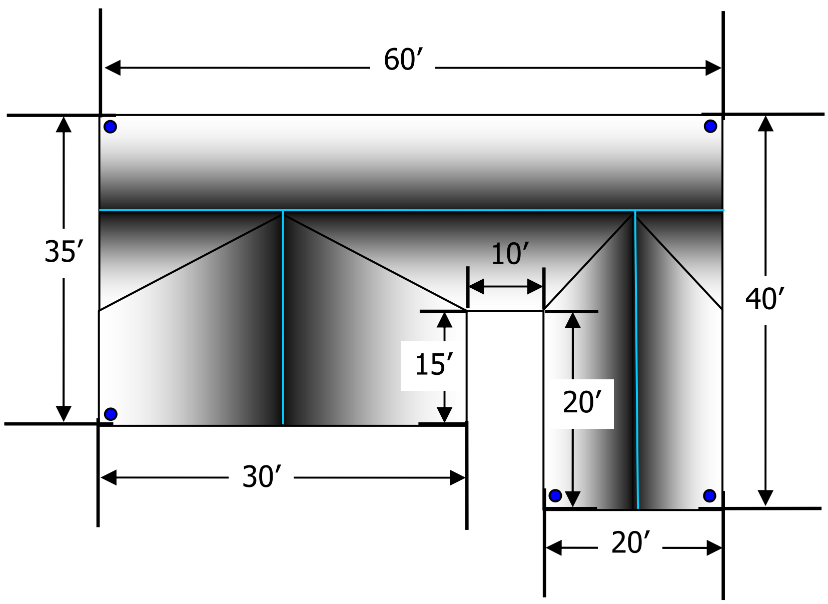
1. Sketch the footprint of your house
2. Indicate the length of each side



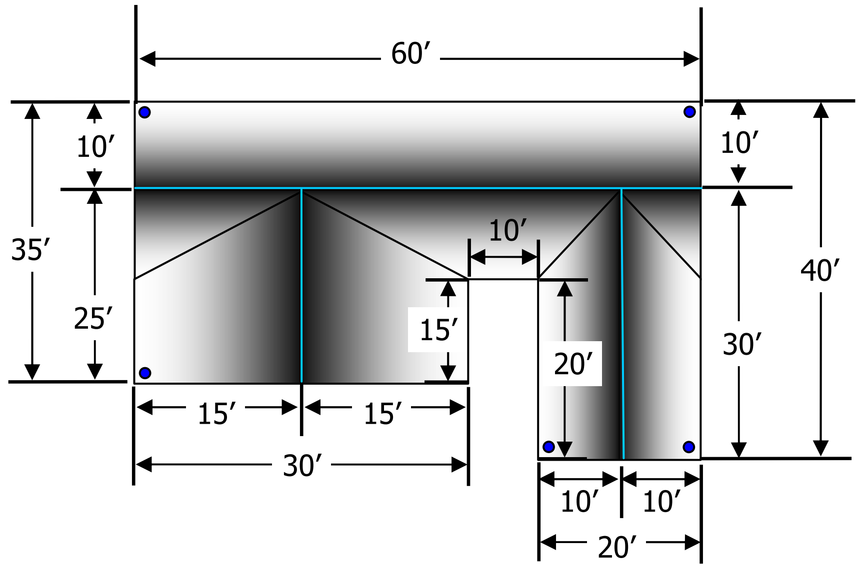
3. Identify locations of downspouts



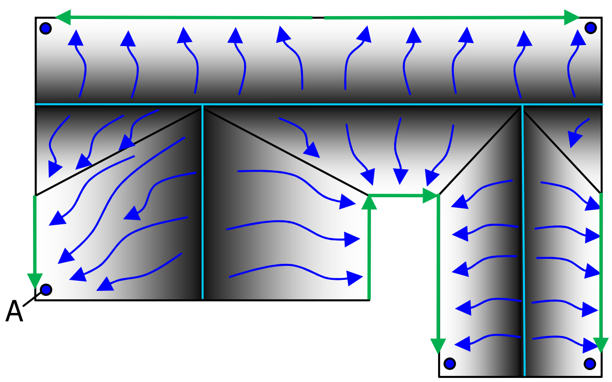
4. Delineate the ridges of the rooftop



a. If the ridges intersect any of the sides, measure and indicate on sketch approximate distance from ridge to each of the closest downspouts



5. Determine the flowpaths to each of the downspouts (i.e., identify which areas flow to each downspout)
   a. If an area is connected to two downspouts, assume that half of the area drains to each (see the top area in the figure below)
      i. **Note:** The blue arrows indicate the direction of flow from roof ridges to gutters, while the green arrows indicate the flow direction through the gutters to the downspouts



6. For each downspout calculate the area that is draining to it

   For example, to calculate the area that is draining to downspout A, use the lengths shown in step 3a.

   15′ x 25′ = 375 sq. ft. (This is the area that contributes runoff to downspout A)

5.3 Disconnect Downspouts

Figure 5-1: Example of disconnected downspout that directs runoff to pervious area

What is disconnecting downspouts?

Disconnecting downspouts diverts water from roof gutters to (1) vegetated pervious areas of the site in order to allow for infiltration, storage, evapotranspiration (i.e., evaporation and uptake of water by plants), and treatment, or (2) a rainwater collection system (e.g., rain barrel). Disconnected downspouts differ from conventional downspout systems that provide a direct connection of roof runoff to storm water conveyance systems (storm drains), which quickly collect and convey storm water away from the site.

How does disconnecting downspouts aid in storm water management?

Disconnecting downspouts decreases the amount of runoff entering the storm water conveyance system and reduces pollution carried by storm water. In addition, the runoff may be put to better use if it is directed to your lawn or garden or is captured in a rain barrel for later use. In contrast, conventional systems that directly connect roof runoff to storm water conveyance systems can have significant environmental impact. The storm water in the conveyance system has higher velocity, volume, and pollutants than runoff from pervious vegetated areas. In Santa Barbara, the storm water conveyance system is not connected with the sanitary sewer treatment system. Instead, storm water exits the conveyance system into the creeks and ocean untreated. The high velocity, volume, and pollutants exiting the conveyance system into streams and ditches can have a significant environmental impact by eroding stream channels and harming aquatic life.

How do I disconnect my downspouts?

Prepare a plan for your site by following these steps:

1. Observe the existing conditions
    a. Are your downspouts draining to your lawn already? Or are they connected to the storm water conveyance system (look to see if the downspouts connect to impervious areas (e.g., a driveway, a street, gutters) or pipes underground that direct the runoff to storm drains)? Or do the downspouts

drain into another type of storm water management system (i.e., drywell, soakage trench, rain barrel, etc.)?

2. Prepare a sketch of your site
    a. Include locations of existing downspouts
    b. Delineate which portions of the roof drain to which downspout and estimate the area that drains to each downspout (see Section 5.2.3 for methods of calculating areas that drain to each downspout)
    c. Indicate locations where disconnecting a downspout may cause a hazard (e.g., disconnection would cause runoff to cross a walkway or driveway, damage a structure, site slopes exceed 15%, etc.)
    d. Indicate the locations of retaining walls, septic systems and their drain fields, underground oil tanks, and any areas where the surrounding landscape slopes towards the house
    e. If roof runoff will be directed to pervious vegetated area, delineate areas where downspouts may be diverted to:
        i. Estimate the pervious vegetated areas available for the diverted runoff to soak in
        ii. Downspouts should be diverted to areas where they will have enough capacity for the rain to soak in; at least 10% of the area that is draining to it
3. Consider directing runoff from downspouts to one or more other Basic BMP options (e.g., rainwater gardens, or rain barrels) or Storm Water Runoff BMP options (see Chapter 6). This may increase your ability to disconnect downspouts based on site conditions. Disconnected downspouts when used in combination with other BMPs can allow runoff to be: (1) collected away from a foundation and infiltrated; (2) diverted away from foundations, spread out and infiltrated; or (3) collected and stored for on-site reuse (see Section 5.6 for Tier 1 and 2 projects and Section 6.9.1 for Tier 3 projects for more information on rain barrels and cisterns).
4. Obtain materials needed for disconnection:
    a. Tools: Tape measure, Hacksaw, Drill, Pliers, Screwdriver
    b. Elbow (<90°)
    c. Downspout extension (if applicable)
    d. Plug or cap for the standpipe (if applicable)
5. If roof runoff will be directed to vegetated pervious areas or other Basic or Storm Water Runoff BMP options other than rain barrels and cisterns:
    a. Design the downspout to be:
        i. Equipped with an elbow at the outlet to direct runoff sufficiently far (4 to 6 feet) from the foundation to prevent foundation damage and basement flooding

ii. Protected at the outlet of the elbow with a type of energy dissipation (e.g., splash blocks – see Section 5.4)

b. Plan to add a gutter extension to the elbow or design a conveyance channel to direct the runoff from the elbow to vegetated pervious areas or other BMP(s):

   i. Direct runoff at least 10 feet away from foundations (including the neighbor's foundation) using a downspout extension, rock or vegetated channel, flow spreading (see Section 5.4), other method, or combination of methods that protects against erosion.

c. Design the vegetated pervious area or other BMP

   i. Ensure that the location you are diverting the runoff to is of adequate size. If you are choosing to combine disconnected downspouts with another BMP, make sure you have designed and checked the feasibility of implementing the other BMP on-site prior to assuming that the water from the downspout will be diverted to that BMP.

6. If roof runoff will be directed to a rain barrel (Tier 1 and Tier 2 projects), go to Section 5.6 for more information on sizing and installation. If roof runoff will be directed to a cistern (i.e., a large rain barrel) for Tier 3 projects, go to Section 6.9.1.

7. Steps for disconnecting your downspouts

   a. Locate where you will cut the downspout

      i. Should be a minimum of 9" above ground level to ensure that there is enough of a slope downward to drain all of the water. However, if you choose to combine with another BMP you may need to adjust where you cut the downspout (check the design constraints of the other Basic and Storm Water Runoff BMPs)

   b. Use a hacksaw to cut the downspout

   c. Attach (with screws or other fastening method) the elbow. Make sure the elbow fits around the outside of the downspout to prevent leaks.

   d. Install some type of energy dissipation at the outlet of the elbow (e.g., splash block, river rock).

   e. If applicable, install a downspout extension, rock or vegetated channel, flow spreader (See Section 5.4), or other conveyance method to direct runoff away from the foundation and/or towards another BMP. If using a downspout extension, attach the extension with screws or other fastening method. Again, make sure that the extension fits around the outside of the elbow.

Maintenance Considerations

Annually conduct the following activities:

- Check to see that connections are not leaking; if they are, repair the joints

- Caulk any leaks or holes that are found
- Inspect for any damage on the downspout components
- Check to make sure there are not any clogs
    - Clear any buildup in elbows and gutters; this may need to be done more frequently if there are overhanging trees
- Check to make sure that the conveyance system of the roof runoff is adequately protecting the underlying soil. If rock has been displaced or vegetation eroded and bare spots are evident, replace the rock or add new rock or vegetation to adequately cover the bare spots.

5.4 Flow Spreading

What is flow spreading?

Flow spreading is a technique that spreads runoff out over a vegetated pervious area, rather than concentrating and conveying the runoff to a storm water conveyance system (storm drain inlets and drain pipes).

How does it aid in storm water management?

Flow spreading distributes concentrated runoff over a larger grassed or vegetated pervious surface, which allows runoff to infiltrate more efficiently than the limited surface in a swale or channel. In addition, when spreading occurs over a grassed or vegetated area, the runoff is infiltrated or filtered by the vegetation and the spreading minimizes risk of erosion. Excess runoff that is not infiltrated flows across the flow spreading area, thereby decreasing the travel time of the runoff and can be directed towards a natural area or a storm water conveyance system. Runoff infiltration can be enhanced when flow spreading is used in combination with soil amendments (see Section 5.10).

Figure 5-2: Flow Spreading - Directing runoff from a disconnected downspout away from a foundation (University of California, Santa Barbara)

What applications are best?

Flow spreading is a versatile practice that may be employed in a variety of ways and in a variety of locations. It may be used to spread and infiltrate runoff from driveways, disconnected roof downspouts, and other open surfaces, either pervious or impervious.

How do I accomplish flow spreading?

While there are a variety of devices to promote the spreading of runoff, they all require runoff to flow over a vegetated path or gravel/rock bed for a specified distance (depending on device). The path slows, filters, stores, infiltrates, and spreads the runoff. Some devices commonly used for flow spreading are splash blocks, rain drains, and rock pads.

Splash blocks

Splash blocks are the simplest of the devices and are generally used to spread concentrated runoff from disconnected downspouts and may be used in conjunction with a conveyance channel (e.g., rock or vegetated) or a downspout extension to move water away from the foundation. Downspout extensions are available commercially (at hardware stores) in a variety of materials and styles and cost between $5 (plastic) and $100 (pre-cast cement).

Rain Drains

Rain drains are plastic tubes that attach to downspout extensions that direct runoff away from the foundation and contain holes that spread the runoff out by acting like a sprinkler head. Some have metal coils that retract when there is not enough runoff to fill the tube and extend when runoff begins to fill the tube. They are available commercially (at hardware stores) for less than $10.

Rock Pads

Rock pads are constructed with crushed rock and oriented perpendicular to the direction of runoff. Typically rock pads are used next to driveways to accommodate driveway runoff, especially if other impervious areas drain to the driveway. A rock pad should be 2 feet wide by 3 feet long and six inches deep. Rock pads need to be constructed on-site and should use clean rock.

Design Considerations

1. No more than 700 square feet of impervious surface may drain to a single flow spreader (of those mentioned in this section)
2. Vegetated flow path must be:
   a. At least 50 feet long
   b. Well-established with lawn or other dense groundcover
   c. No steeper than 15% (see Section 5.2.2 for estimating site slope)
   d. Located between the flow spreader and any downstream drainage; the vegetated flow path may be located within a critical buffer area, though flow spreaders themselves are NOT permitted within a critical buffer area
3. The spreading of flow must not create any flooding or erosion problems
4. Sites with septic systems should locate the vegetated flow path down slope of primary and reserve drain fields

Maintenance Considerations

Annually, the following maintenance activities should be conducted:

1. Inspect for any damage to the flow spreader, repair if required
2. Inspect vegetated flow path to ensure that vegetation is uniformly distributed and provides dense cover; revegetate areas that do not meet this requirement
3. Repair signs of erosion immediately by using temporary erosion control until vegetation can be established
4. Check to make sure there are not any clogs

5.5 Rainwater Gardens

What is a rainwater garden?

Rainwater gardens are landscaped depressions that collect and store storm water runoff allowing it to infiltrate, evaporate, and nourish plants. Rainwater gardens mitigate the environmental impacts of land development and provide attractive landscaping and habitat for many animals, including birds, butterflies, and insects. While rainwater may be used to irrigate any garden, rainwater gardens are intended to provide storage and; therefore, require sloped sides, berms, and hardy plants that can withstand periods of flooding as well as drought.

Figure 5-3: Rainwater garden implemented in the front yard of a single-family Santa Barbara residence

How does a rainwater garden aid in storm water management?

Rainwater gardens are a type of bioretention BMP that retain and infiltrate storm water runoff and reduce the rate, volume, and pollution carried by storm water. While the plants in the rainwater garden transpire water (uptake water from their roots) and utilize nutrients, the plants and the soil filter, uptake, and biodegrade pollutants. In addition, the infiltrating rainwater may recharge groundwater.

Where should rainwater gardens be used?

Rainwater gardens may be used in a variety of locations, including new and existing developments. For residential homes, front and back yards are good locations as long as the location will intercept runoff naturally or if runoff can be collected and routed with a diversion berm, natural conveyance channel, or landscape pipes.

What does it do? Or How does a rainwater garden work?

Rainwater gardens collect and store runoff from downspouts and other sources and allow it to slowly seep into the ground rather than flow directly to a storm water conveyance system (storm drain inlets and drain pipes). The bottom of the garden is level to ensure uniformly distributed infiltration; however, the surface of the garden should be bowl shaped and should gently slope up to the ground level along the edges to minimize risk of erosion. A berm surrounding the garden contains water in the garden. Native hardy plants that can withstand flooding as well as drought provide an attractive landscape and wildlife habitat in addition to enhancing the infiltration capacity of the garden.

Rainwater gardens are not ponds and should not retain water for more than 48 hours after the rain stops. Depending on the infiltration capacity of the soils, it may be necessary to line the bottom of the garden with a layer of sand to promote infiltration while adding some storage capacity or amending the soil with sand, organic material, and/or top soil (see Section 5.10).

How much does a rainwater garden cost?

A rainwater garden costs between nothing (if you do all of the work yourself and do not have to purchase plants) and $10-12 per square foot if you hire a landscaper (Bannerman & Considine, 2003).

Components

- Soil amendments
- Plants
- Conveyance channel (e.g., rock or vegetated concave path)

Site Considerations

1. Determine where the runoff to the garden will originate (e.g., which disconnected downspout) and determine the amount of the impervious area that will drain to the rainwater garden (See Section 5.2.3). If one side of the house drains to two downspouts, assume that half goes to each downspout.
    a. The rain garden size can vary between 5% and 30% of the impervious area that drains to it depending on the soil type (i.e., if the soils are more clayey, infiltration will happen more slowly and more rainwater garden surface area will be required)
2. Identify slopes (natural drainageways), soil types, and infiltration capacity of existing soils (see design considerations below for soils), and if using a natural flowpath for conveyance to the garden ensure that the water will reach the garden (i.e., if flowpath has a high infiltration rate the rainwater may infiltrate in the flowpath before reaching the garden; you may wish to consider using alternative conveyance or moving the garden closer to the runoff source, at least 10 feet from house foundation).
3. Once a possible location has been identified, that location should be investigated to determine which type of soil is dominant as well as if the location and its tributary path have adequate drainage (See Section 5.2.1).

Design Considerations

1. Size and shape of the rainwater garden
    a. Should not exceed 300 sq. ft. in area or should not be sized to capture runoff from more than 4,000 sq. ft. of impervious area; if the size exceeds one of these criteria, sizing should be based on calculations for bioretention areas (see Section 6.6.1)
    b. Can vary between 5% and 30% of the impervious area that drains to it depending on soil type
    c. Side slopes should be no steeper than three horizontal to one vertical (3H:1V)
    d. Ponding depth should be shallow (maximum of 6 - 8 inches)

e. Once the impervious area draining to the rainwater garden and the desired ponding depth are determined, utilize a sizing factor shown in Table 5-2 to calculate the area needed for the rainwater garden with the following formula:

$$Size\ of\ rainwater\ garden = size\ factor \times drainage\ area$$

Table 5-2: Sizing factors for Rainwater gardens ***(modified from Bannerman, 2003)***

Soil Type	6-7 in. deep	8 in. deep
Rainwater gardens between 10 and 30 feet from downspouts		
Sandy	0.15	0.08
Silty	0.25	0.16
Clayey	0.32	0.2
Rainwater gardens more than 30 feet from downspouts		
Sandy	0.03	
Silty	0.06	
Clayey	0.10	

For example, use the area that drains to downspout A as calculated as 375 square feet in Section 5.2.3. To minimize the amount of area required for the garden, 8" of ponding depth was chosen. From the texture by feel test (see Section 5.2.1), it was determined that the soil was silty. Therefore, the sizing factor from Table 2-2 is 0.16.

Size required for rainwater garden = 0.16 x 375 sq. ft. = 60 sq. ft.

2. *Location*
   a. Full to partial sun
   b. At least ten feet from a building foundation
   c. Do not locate over shallow utilities (have utilities located before digging)
   d. Do not locate where the seasonally high groundwater table is within two feet of the bottom of the rainwater garden
   e. Site slope should be less than 15%
   f. Should not be located near (i.e., within 50 feet) of steep slopes (>25%)
   g. The area draining to garden should be stabilized prior to building the garden
   h. If pre-treatment is necessary, locate downstream of a vegetated filter strip (See Section 6.6.3)

   i. If flow spreading is desired prior to entering the garden, use a flow spreader or vegetated filter strip that directs runoff to the garden as shallow sheet flow instead of in a concentrated channel

3. *Soils*
   a. NRCS hydrologic soil groups "A" and "B" are appropriate for rainwater gardens (see maps in Appendix B for a general idea if you may be located in an area with these types of soils)
      i. You may wish to use http://websoilsurvey.nrcs.usda.gov/app/ to see a map of the soil survey based on your address
   b. Check to ensure that adequate infiltration is available by using the simple infiltration method (Tiers 1 and 2) or the more complete soil assessment (Tier 3); see Section 5.2.1 or Chapter 3, respectively
   c. Compaction should be avoided
   d. Soil amendments may be needed (see Section 5.10)
4. *Plants*
   a. Based on site conditions
   b. Use native species as often as possible (see Section 5.11 for planting guidance and Appendix G for a plant list appropriate for rainwater gardens)
      i. Use species that can tolerate flooding as well as drought
   c. Use a variety of different plants (heights, colors, bloom times, etc.) to enhance the wildlife function of the garden
   d. Consider view to and from the street (you don't want plants that completely block the view)
   e. Tallest plants should go in the center or deepest area of the garden

Maintenance considerations

Quarterly maintenance activities:

1. Repair signs of erosion immediately
2. Inspect plants
3. Remove weeds, or more frequently as needed

Annual maintenance activities:

1. Test soil (see Section 5.2.1)
2. Inspect for excess sediment
3. Replace plants as needed
4. Prune as needed

Every two years maintenance activities:

1. Replace mulch

Infrequent maintenance activities:

1. Inspect for excess sedimentation periodically for the first 19 years and regularly after about 20 years; remove sediment when necessary

For more information on sizing and installing rainwater gardens, see the following website:

Rain Gardens: A how-to-manual for homeowners:
http://clean-water.uwex.edu/pubs/pdf/home.rgmanual.pdf

LID Center – Rain Garden Design Template
http://www.lowimpactdevelopment.org/raingarden_design/

5.6 Rain Barrels

What is a rain barrel?

Rain barrels are aboveground storage vessels that capture runoff from roof downspouts during rain events and store that runoff for later reuse for irrigating landscaped areas. However, rain barrels do not hold large volumes of water (typically less than 100 gallons), but may be connected in series. For larger applications, cisterns (large rain barrels) should be used. See Section 6.9.1 for more information on sizing cisterns.

How does a rain barrel aid in storm water management?

Rain barrels detain (temporarily hold) roof runoff, reducing the runoff volume from a property and may reduce the peak runoff velocity for small, frequently occurring storms. In addition, by reducing the amount of storm water runoff that flows overland into a storm water conveyance system (storm drain inlets and drain pipes), less pollutants are picked up and transported through the conveyance system into local creeks and ocean. By infiltrating rainwater using irrigation or other infiltration process, groundwater is also being recharged. Furthermore, by storing rainwater for reuse for irrigation, potable water is conserved.

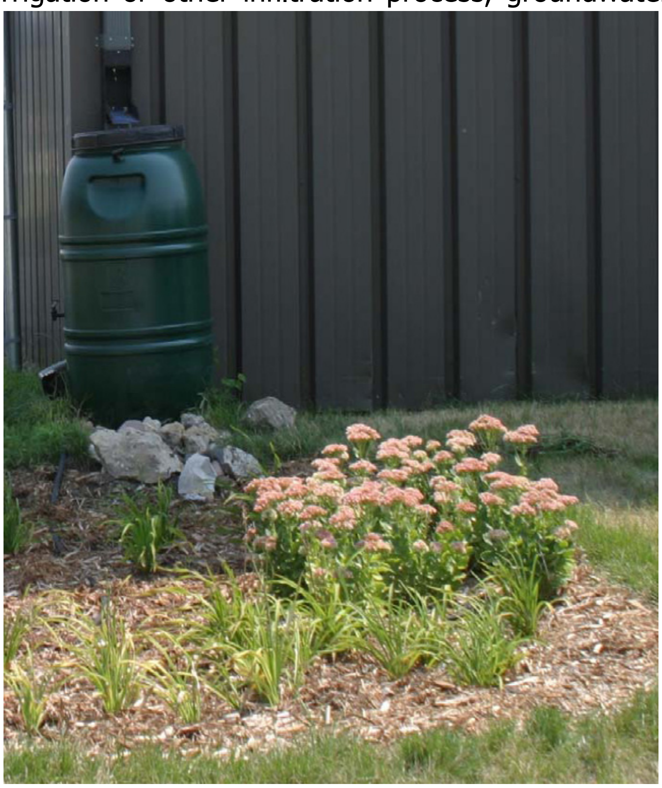


Figure 5-4: Rain barrel blends into surroundings

Photo Credit: Illinois Public Works Department

What applications are best for a rain barrel?

Rain barrels are typically used in residential settings and located near existing downspouts.

What does it do? Or how does a rain barrel work?

Rain barrels are located near existing roof downspouts so that the flows from the existing downspouts are diverted easily into the rain barrel. Rain barrels fill from the top (through a screen or grate to filter coarse sediment) and empty either by draining through the bottom of the tank by gravity flow or with the assistance of a pump through the top or bottom of the tank. Rain barrels may be operated either as a reservoir for temporary storage of runoff (emptied in between events), or as a flow control unit that temporarily stores and slowly releases runoff.

As a **reservoir**, the valve remains closed during storm events to collect runoff and must be emptied between storms and used for landscape irrigation or other non-potable water use so that the barrel is empty and ready to capture runoff from the next storm. As a **flow control**

unit, the valve remains partially open and releases the water from the barrel at a slower rate than the rate that it fills the barrel. In either case, an overflow must be provided for when the barrel is filled. Ideally, the overflow of water from the barrel will remain on-site and be dispersed into vegetated pervious areas using a splash block or other type of flow spreading method to allow for infiltration or be captured, stored, infiltrated, and/or treated in another type of BMP. Overflow should be conveyed away from the structure and neighboring structures. However, where infiltration is slow, and the existing downspout has a connection to the storm water conveyance system, it may be advised to connect the overflow directly into the storm water conveyance system.

Where do I get a rain barrel?

Rain barrels are available for purchase in a variety of shapes, sizes, and materials allowing for aesthetically pleasing incorporation into the site. New rain barrels can be purchased online, and local gardening and home supply/repair stores are beginning to stock their inventory with rain barrels.

How much does a rain barrel cost?

Prices for rain barrels range from $60 to several hundred dollars, depending on style and capacity.

Components

1. Water tight container
2. Overflow mechanism
3. Screen to provide vector control, safety, and prevent clogging
4. Outlet spigot or hose
5. Inlet gutter or hose

Design considerations

1. Should be aesthetically incorporated into surroundings by:
   a. Painting it the same color as the house so that it blends in,
   b. Placing it under a raised deck or within a structure so it is hidden,
   c. Surrounding it with vegetation and/or an aesthetically appealing structure such as a lattice screen, and/or
   d. Using a rain barrel that fits the surrounding theme (e.g., an old wine barrel)
2. Should be designed to minimize clogging from leaves and other debris, prevent drowning, and provide vector control; inlet should be covered with a fine screen
3. If intending to use the collected water for a specific purpose you may desire to collect more water than can be stored in one barrel, if that is the case, barrels may be connected in series (i.e., overflow from one barrel connected as an inlet to the next)

If you purchased your rain barrel with inlet and outlet included:

1. Install barrel using the instructions that came with the barrel (if available). The following is only intended to provide general guidance:
    a. The barrel should be installed and secured (to prevent it from falling over) on a foundation (concrete blocks work well). It will need to be high enough so that you can access the water (either with a hose or a bucket).
        i. Rain barrels are often installed on a platform to allow some maneuverability for getting water from the outlet of rain barrel. Since the outlet is often near the bottom of the barrel to allow the water to drain out by gravity flow, raising the barrel off the ground allows insertion of containers such as water cans for ease of filling.
    b. Caution should be taken to ensure that the barrel remains child safe. You do not want a child to be able to get into or tip over a barrel full of water.
    c. Once the barrel is in place, you will be able to determine where the downspout will need to be cut. Using the new elbow that will be installed on the downspout (see Section 5.3), hold it near the barrel so that you can see how high up you will need to cut the downspout to install the new elbow allowing some space (approximately 1") between the bottom of the elbow and the top of the barrel/screen.
    d. Using a hacksaw, cut the downspout, and attach the elbow or other device used to get runoff into the barrel.
    e. Ensure overflow is connected to another barrel, back into the storm water conveyance system, or other pervious surface that will be used for infiltration
    f. Test the rain barrel's operation
        i. If using a hose attached to the outlet to remove water that collects in the barrel, the end of the hose must be lower than the level of the water in the barrel for the water to drain out of the barrel.

Maintenance Considerations

Periodic maintenance activities:

1. Remove debris that collects on inlet screen; if the debris includes roofing materials, place it in the trash; if the debris is mainly dirt and vegetation, place it in a green waste container.

Annual maintenance activities:

1. Clean barrel out; do NOT dump water in the barrel onto a driveway, sidewalk, or street; clean barrel out over lawn or other permeable area.

5.7 Contained Planters

What is a contained planter?

Contained planters are containers that hold soil and plants, providing areas of pervious surface in otherwise impervious areas.

How do contained planters aid in storm water management?

Contained planters decrease the imperviousness of an area (e.g., in tightly confined urban areas with little pervious area) by "covering" up the impervious area with pervious area and reduce the amount of runoff that occurs from impervious surfaces. Planters provide space for soil and plants that retain (except during large storms) storm water runoff rather than allowing it to flow directly to the storm water conveyance system (storm drain inlets and drain pipes) and then to local creeks and oceans. The retained storm water runoff is then evaporated or transpired (water taken up by plants) from the planter. In the event of a large storm, excess water from the planter may drain out the bottom or through a provided overflow structure.

Figure 5-5: Contained planters with trees and flowers

Photo Credit: Geosyntec Consultants

What applications are best for contained planters?

Contained planters are an excellent choice for implementing in an urban area that is impervious. They may be placed on impervious areas such as parking areas, rooftops, sidewalks, and patios.

How much does a contained planter cost?

Planters are inexpensive and may be purchased at a variety of locations, including hardware, garden, and multi-purpose stores or built relatively easily.

Components

- Contained planter
- Soil
- Plants

Design Considerations

1. Plants should be hardy, native, tolerant of drought and flooding, and self-sustaining to minimize need for fertilizers and pesticides
2. Depending on the size of the planter, plants may include trees, shrubs and/or ground cover (See Section 5.11 and Appendix G for ideas on which plants to use)
3. Depending on the types of plants chosen determine what type of soil should be used (See Section 5.10 for information on soil amendments)
4. Planters are widely available in a variety of shapes and sizes and may be created by recycling other containers
5. If you build a planter, or convert recycled items into planters:
   a. Remember that holes should be drilled in the bottom to allow excess water to drain (you don't want to drown the plants)
   b. It should not be made with treated wood that may leach toxic chemicals.
6. Planters may be permanently affixed (built-in) or separate units that may be moved around as desired.
7. Planters, depending on size and location, may need to have an overflow structure to accommodate larger flows that may drown the plants if not diverted

Maintenance considerations

Occasional maintenance activities:

1. Fertilizer may be needed, in which case it should be a slow acting organic fertilizer that will not contaminate the runoff from the planter with nutrients.
2. Soil should be tilled to improve infiltration.

5.8 Depression Storage

What is depression storage?

Depression storage is the use of depressions, either artificial or natural, on a site for storing storm water runoff to allow it to soak in. This method is similar to rainwater gardens, in that it must be vegetated and its purpose is to promote infiltration; however, its vegetation should be grass or some other dense groundcover, rather than a combination of trees, shrubs, and groundcovers.

Figure 5-6: Depression Storage
Photo Credit: New Zealand Water Environment Research Foundation

How does depression storage aid in storm water management?

Depression storage promotes infiltration and reduces runoff volumes and rates as well as pollution. Depression storage contains storm water runoff by providing an area on the surface for water to build up or accumulate during a storm and slowly soak into the ground.

What applications are best for depression storage?

Existing natural depressions, provided that they are adequately maintained, is a primary source of depression storage in yards. In addition, they may be created by grading the site.

How do I create/maintain depression storage?

Large depression storage may be created by grading your lawn so that the center is just a few inches shallower than the edges of the lawn. Small depression storages are created the same way, but are shallower and confined to a smaller area. Small depressions on slopes may drain into one another, assuming that conveyance in between is stabilized sufficiently to prevent erosion.

Design Considerations

1. Determine if soils are infiltrative enough for depression storage:
    a. Check to ensure that adequate infiltration is available by using the simple infiltration method for Tier 1 and Tier 2 projects or the more complete soil

assessment for Tier 3 projects. See Section 5.2.1 or Chapter 3, respectively, for more information on conducting these tests.

2. Depression storage should be created by excavation of native soil rather than built up like a berm.
3. Ponding depth should be shallow (maximum of 6 - 8 inches)
4. Compaction should be avoided.
5. Should be designed to provide vector control
6. Side slopes should be no steeper than three horizontal to one vertical.
7. Multiple depressions should be separated by a minimum of four feet.
8. Depression overflow point should be located such that it does not cause erosion or inadvertent inundation.
9. Location
    a. At least ten feet from a building foundation
    b. Do not locate over shallow utilities (have utilities located)
    c. Do not locate where the seasonally high groundwater table is within two feet of the bottom of the depression
    d. Site slope should be less than 15%
    e. Should not be located near (i.e., within 50 feet) of steep slopes (>25%)
    f. If flow spreading is desired prior to entering the depression, use a flow spreader or vegetated filter strip that directs runoff to the depression as shallow sheet flow instead of in a concentrated channel

Maintenance considerations

Depression storage features should be as easy to maintain as your current lawn, they should only require mowing of the grass and repair of erosion if evident. If dense, native groundcovers are used in place of turf grass, then they may not require mowing but may require some trimming.

5.9 Permeable Pavement for Single-Family Residences

What is permeable pavement?

Permeable pavements contain small voids (holes) in the pavement that allow water to pass through to an underground stone reservoir (open-graded base) where runoff accumulates and is stored while it either infiltrates into the soil (soil subgrade) or is slowly released to a storm water conveyance system (storm drain inlets and drain pipe) or to a another type of BMP.

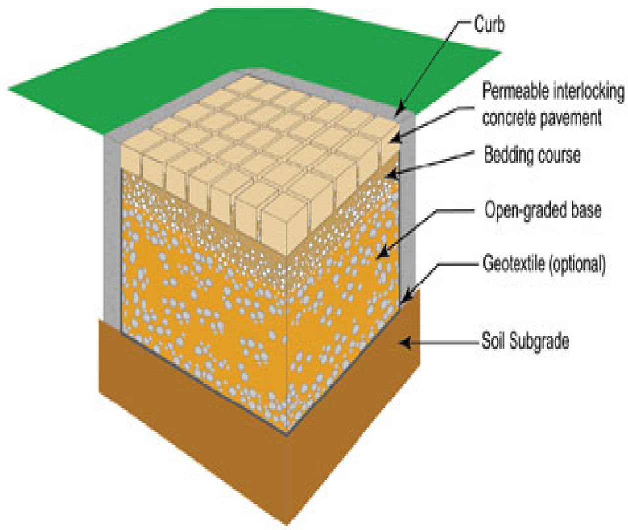


Figure 5-7: Typical permeable pavement cross-section

Diagram Credit: Interlocking Concrete Pavement Institution

How does permeable pavement aid in storm water management?

Permeable pavements help decrease storm water runoff volume, reduce storm water runoff velocities, and improve water quality by filtering storm water through the stone reservoir, and when soil infiltration rates allow, by allowing it to filter through the soil beneath the stone reservoir.

What applications are best for permeable pavement?

Permeable pavements come in a variety of forms; they may be a pour in place type system (porous concrete, permeable asphalt) or a modular paving type system (concrete pavers, grass-pave, or gravel-pave). Modular paving systems are most appropriate for single-family residences (Tier 1 and Tier 2 projects).

Figure 5-8: Permeable pavers in a driveway in front of a single-family residence in Santa Barbara.

Concrete Pavers

For single-family residences, concrete paver can be used in place of impervious concrete or asphalt surfaces in such places as driveways, parking areas, patios, and walkways.

Figure 5-9: Grass paver blocks in a residential driveway
Photo Credit: Roger Bannerman

Grass-Pave

For single-family residences, grass-pave is most applicable for driveways and parking areas providing support for the weight of vehicles but allowing the driveway to be mainly grassed and pervious.

Gravel-Pave

Figure 5-10: Gravelpave[2]
Photo Credit: Gravelpave[2]

For single-family residences, gravel-pave can be used for driveways, parking areas, and walkways with some restrictions. The gravel-pave must be at least 200 feet from the street for driveways and parking areas, which prevents gravel from being displaced from vehicles onto streets. If the driveway or parking area is to be used for fire access, approval must be provided from the fire department. Gravel-pave should not be placed on walkways that are required to handicap accessible.

How do I create/maintain permeable pavement?

For more information on sizing, designing, and construction of permeable pavement, see Section 6.8.

5.10 Soil Amendments

Figure 5-11: Soil amended area at U.S. EPA Ariel Rios Building
Photo Credit: Low Impact Development Center

What are soil amendments?

A soil amendment is anything that is added or done (e.g., aeration) to the soil to alter its physical, chemical, and biological characteristics. Compost and fertilizers are common soil amendments that must be completely mixed into the soil to function properly.

How do soil amendments aid in storm water management?

Soil amendments alter the soil characteristics to allow it to reduce runoff volume and velocity, filter pollutants, increase the quality and quantity of vegetation, and reduce erosion potential more effectively than soils without soil amendments. Mulch is an amendment that is added on the top of the soil, rather than mixed into the soil, which reduces evaporation and adds to the aesthetics of a site.

How much do soil amendments cost, how are they applied and why?

Table 5-3 below outlines different soil amendments, the depth of the amendment, how it is used, and how it improves the soil.

Table 5-3: Soil Amendments and their specifications

Item	Depth	Cost *(2008 dollars)*	Specifications	Purpose
Soil Clearing and Testing	6″ – 12″	$3 - $5/sq. yd.	Clearing and grubbing; soil infiltration testing	Evaluate soil compaction and organic nutrient content/requirements
Nitrolized Redwood Shavings	6″ – 12″ (i.e., depth to which the shavings should be mixed in)	$95/cu. yd.	Roto-till shavings into native soil	Increase infiltration rates and water retention properties of soil
Compost/ Soil Conditioners/ Fertilizers	6″ – 12″ (i.e., depth to which the compost, soil, or fertilizers should be mixed in)	$95/cu. yd.	Roto-till into native soil	Increases infiltration rates, water retention properties, and nutrient content of soil

Item	Depth	Cost (2008 dollars)	Specifications	Purpose
Bark Mulch	At Grade	$10-$30/cu. yd.	Spread over all planting areas to a depth of 3"	Reduces evaporation and increases water retention properties of soil

Where should soil amendments be added?

Soil amendments can improve the properties of almost any soil and should be incorporated where existing soil is in poor condition (e.g., lack of nutrients, minimal infiltration, etc.). Amendments may also be added where they may increase the effectiveness of a BMP, or to alter conditions in order to accommodate the implementation of a BMP. Soil amendments are common components of several infiltration BMPs, including rainwater gardens, depression storage, bioretention, vegetated swales and filter strips, infiltration basins, planter boxes, green roofs, dry extended detention basins, wet retention basins, constructed treatment wetlands, and general landscaping. Soil amendments should not be applied in naturally wooded areas or on slopes steeper than 15%.

Maintenance considerations

Care should be taken when adding fertilizers; more is not necessarily better. Applying fertilizers in excess may be washed off and contaminate storm water.

Annual maintenance activities:

1. Inspect soils for signs of compaction, waterlogged areas and diseased vegetation (may be a sign of too much water).
2. Test soils to determine infiltration condition of soils and what amendments may be needed (see Section 5.2.1).
3. Re-aerate, till or add additional amendments to the soil if infiltration rates have decreased noticeably or there are signs of compaction.

5.11 Ribbon Driveways

What is a ribbon driveway?

Ribbon driveways are constructed of two parallel strips of pavement for automobile wheels, with a pervious surface (e.g., gravel, grass, or other low growing vegetation) in between. Other names for ribbon driveways are "hollywood" driveways, paving-under-wheels driveways, and strip driveways.

How do ribbon driveways aid in storm water management?

Ribbon driveways decrease the amount of impervious surface by limiting the pavement area to narrow driving strips. Ribbon driveways increase the amount of pervious area and disconnect impervious surfaces by allowing the runoff from the driving strips to drain to landscaping. Ribbon driveways decrease the amount of runoff entering the storm water conveyance system and reduce pollution carried by storm water. In contrast, conventional driveways that directly connect roof runoff to the storm water conveyance system increase the rate and volume of runoff by not providing opportunity for runoff to be slowed, infiltrated, or treated. Depending on whether the storm water conveyance system is connected with the sanitary sewer (meaning both flow together in the same pipe), storm water can either exit the conveyance system into a stream, ditch, or the ocean or it can flow to a wastewater treatment plant. The high velocity, volume, and pollutants exiting the conveyance system into streams and ditches can have a significant environmental impact by eroding stream channels and harming aquatic life.

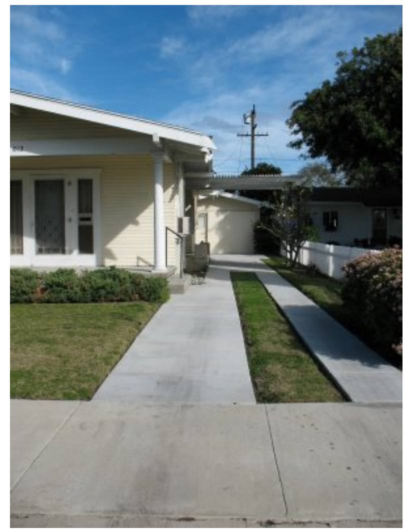


Figure 5-12: Ribbon Driveway
Photo Credit: Good Home Construction, CA

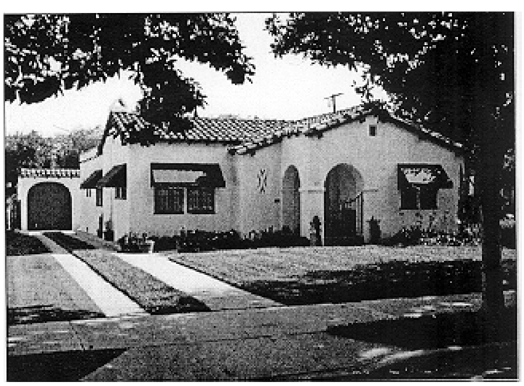


Figure 5-13: Ribbon Driveway
Photo Credit: Fullerton Heritage, CA

What applications are best for ribbon driveways?

Ribbon driveways are an excellent choice for implementing in residential driveways that may be short and straight (making it easier to pave the strips). They may replace existing driveways as well as be used in locations that currently do not have a paved driveway, but require a more substantial driving surface.

Design Considerations

Ribbon driveways often consist of two 2-foot strips of concrete pavement with a permeable strip in between. The center strip can be left open to be planted with grass or groundcover, or filled with a permeable material such as gravel. Ribbon driveways are cheaper to install than conventional driveways.

Maintenance considerations

Occasional maintenance activities:

3. Grass and/or low lying vegetation should be mowed to allow clearance for vehicles.
4. Fertilizer may be needed for vegetation, in which case it should be a slow acting organic fertilizer that will not contaminate runoff with nutrients.
5. Soil within the center strip can be tilled to improve infiltration.

5.12 Landscaping Considerations

What are landscaping considerations?

Revegetating or landscaping a site using trees, shrubs, grasses, or other groundcover provides an opportunity to reintroduce native vegetation, which may be more disease-resistant and require less maintenance than non-native species. Benefits of native landscaping include:

- erosion control/soil stabilization
- runoff volume reduction
- water quality treatment (especially for sediment and nutrients)
- habitat creation
- aesthetic enhancements
- creation of, or addition to, local greenways and wildlife corridors
- reduction of water demands for landscaping

The landscaping considerations apply to general site landscaping, restoration, as well as vegetated Basic BMP and Storm Water Runoff BMP options.

Figure 5-14: Local landscaping

How does landscaping aid in storm water management?

Planting trees, shrubs, grasses, or groundcover in as many areas as possible will reduce the runoff volume, velocity, and pollutants leaving a site by increasing the site's infiltration, storage, and filtering capacity. Depending on the infiltration capacity of the soil, runoff (e.g., from disconnected downspouts) can be routed to a vegetated pervious area or a vegetated BMP to reduce runoff volume, velocity, and pollutant loadings (i.e., pollutant loading is calculated by multiplying the runoff volume by the pollutant concentration; for example, a volume of 100 liters of runoff is multiplied by a concentration of 10 mg/liter of nitrate which equals 1,000 mg of nitrate load). Connecting landscaped areas and vegetated BMPs in a "treatment train" across the site can have a more appreciable effect on reducing runoff volume and velocity than small individual landscape plantings surrounded by impervious surfaces.

Volume reductions will also result from rainfall interception by leaves and increased evapotranspiration (ET) or uptake of rainfall/runoff by plants. Interception and ET will have a greater effect on runoff volume reduction for small, frequently occurring, low intensity storm events.

In addition to plant selection and landscape design, soil preparation is also a critical factor in determining runoff retention on a site. Soil conditions favorable to plant growth generally also provide the greatest runoff volume reduction. Soils must be loose enough to allow water to infiltrate and roots to penetrate. Soil amendments can be used to increase infiltration (see Section 5.11).

How much does landscaping cost?

Table 5-4 outlines different sizes and types of plants that may be used for landscaping as well as the associated costs (i.e., cost per plant and installed costs).

Table 5-4: Landscaping plants and associated local costs

Item	Unit	Unit Price	Estimated Installed Cost*
Tree (24" box size)	Ea	$165 - $210	$300.00 - $350.00
Tree (15 gallon size)	Ea	$45 - $60	$75.00 - $100.00
Shrub (5 gallon)	Ea	$14 - $16	$25.00 - $30.00
Shrub (1 gallon)	Ea	$3 - $5	$6.00 - $10.00
Grass (2" cell)	Ea	$.50 - $1	$2.00 - $3.00
Seed	Sq. ft.	$.05 - $.15	$.25 - $.30

* Indicates in-place cost when installed by a contractor

Where should landscaping be located?

Landscaping, in combination with soil amendments, should be located throughout the site to promote infiltration of storm water runoff. By carefully designing the landscape, you may enhance the infiltration capacity of a site. Increased amounts of vegetation enhance the infiltration rate of soils by utilizing the water themselves and creating larger pore spaces in the soil around the vegetation roots. Landscaping may be planned to incorporate a variety of plants that may benefit the hydrology and ecology of the site through general landscaping, restoration, and incorporation of vegetative BMPs. Contained planters should be located on impervious surfaces to reduce the imperviousness of the site and provide additional pervious area. Bare earth areas should also be landscaped and amended with soils to enhance the pervious areas infiltration capacity. Landscaping techniques may be used to incorporate channels for directing runoff away from foundations and to pervious areas or other basic and/or storm water runoff BMPs, while minimizing erosion. Many of the basic and storm water runoff BMPs in this chapter and in Chapter 6 require the use of landscaping for proper implementation. See each of the individual sections for more specifics regarding the types of landscaping required.

What type of plants should be used for different purposes?

Landscaping provides aesthetics as well as improving infiltration capacity. Plants should be selected for each location based on the purpose they will serve. Landscaping has a large effect on the effectiveness of many BMPs discussed in this Manual. For example, you need to use plants that are tolerant of flooding and drought for rainwater gardens and bioretention areas; requirements that do not need to be met for ordinary landscaping intended for aesthetics and enhancement of infiltration capacity in already pervious areas. See Appendix G for native plant selections that are separated into sections based on BMP type. The plant recommendations in Appendix G are provided as general guidelines only and do not replace the design guidance of a landscape professional.

Design considerations

Landscaping should be chosen carefully based on its intended purpose. In high fire hazard areas, areas prone to erosion, and other sensitive areas, refer to the City's Architectural Review Board Document Section 2: Landscaping Guidelines. For any landscaping alterations greater than 5000 square feet, or that require extensive grading, revegetation, or improvements with unique sensitive habitats or environments, a licensed landscape professional must prepare the landscape plan.

Maintenance considerations

Different landscaping techniques will require different amounts and types of maintenance. While some plants need regular attention (e.g., pruning, addition of soil amendments, on-going periodic irrigation, etc.), others, especially native plants, require regular maintenance (e.g., weeding and irrigation) during establishment then require minimal pruning and irrigation. However, others may need annual pruning. Select plants based on amount of maintenance required. In addition, rock or vegetated channels may be used in landscaping for channeling water away from foundations and into BMPs. These types of conveyance channels need to be inspected for signs of erosion and repaired as needed.

A general schedule of maintenance activities is provided below:

Monthly:

1. Remove weeds

First year:

1. Water as needed, especially during times without rain

Annually:

1. Address erosion, if necessary
2. Replace dead plants
3. Prune plants, as appropriate for each plant

Every 2-3 years:

1. Reapply mulch

For more information regarding landscaping requirements in the City, refer to the City's Landscaping Guidelines:

http://www.santabarbaraca.gov/NR/rdonlyres/1983CCFE-1FFC-474C-A114-F9A584B00C7D/0/070307ABRGuidelinesFULLDOC.pdf

http://www.santabarbaraca.gov/NR/rdonlyres/4384327D-AFF6-46E6-99D6-2BD6B8D194E0/0/Landscape_Design_Standards_for_Water_Conservation.pdf

http://www.santabarbaraca.gov/NR/rdonlyres/0D83C2BD-31F6-4C95-82E2-5763C1C62038/0/Landscape_Compliance_Requirements.pdf

http://www.santabarbaraca.gov/NR/rdonlyres/98B4241F-B4BD-4C2C-99CB-7773A198D6D3/0/EPV_PlantLIST_intable.pdf